

Unit Lesson Plan – Nuclear Physics			
Teacher:	<Teacher>	Time Frame:	6 days
Grade:	9	School:	<School>
Subject:	PSI Algebra Based Physics		

NGSS DCI:	<ul style="list-style-type: none"> • HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. • HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
AP Physics 1 and 2 Standards:	<ul style="list-style-type: none"> • Essential Knowledge 3.G.3: The strong force is exerted at nuclear scales and dominates the interactions of nucleons. • Learning Objective (3.G.3.1):The student is able to identify the strong force as the force that is responsible for holding the nucleus together. • Essential Knowledge 4.C.4: Mass can be converted into energy and energy can be converted into mass. <ul style="list-style-type: none"> a. Mass and energy are interrelated by $E = mc^2$ b. Significant amounts of energy can be released in nuclear processes. • Learning Objective (4.C.4.1):The student is able to apply mathematical routines to describe the relationship between mass and energy and apply this concept across domains of scale. • Essential Knowledge 5.C.1: Electric charge is conserved in nuclear and elementary particle reactions, even when elementary particles are produced or destroyed. Examples should include equations representing nuclear decay. • Learning Objective (5.C.1.1):The student is able to analyze electric charge conservation for nuclear and elementary particle reactions and make predictions related to such reactions based upon conservation of charge. • Essential Knowledge 5.G.1: The possible nuclear reactions are constrained by the law of conservation of nucleon number. • Learning Objective (5.G.1.1):The student is able to apply conservation of nucleon number and conservation of electric charge to make predictions about nuclear reactions and decays such as fission, fusion, alpha decay, beta decay, or gamma decay. • Essential Knowledge 7.C.3: The spontaneous radioactive decay of an individual nucleus is described by probability. <ul style="list-style-type: none"> a. In radioactive decay processes, we cannot predict when any one nucleus will undergo a change; we can only predict what happens on the average to a large number of identical nuclei. b. In radioactive decay, mass and energy are interrelated, and energy is released in nuclear processes as kinetic energy of the products or as electromagnetic energy. c. The time for half of a given number of radioactive nuclei to decay is called the half-life.

Note that this **exact** Smart Notebook presentation has not been used in the classroom, although all of the material has. The pacing below is approximate based on a 40-45 minute class period. Feel free to adjust as necessary and please provide your feedback!

	<p>d. Different unstable elements and isotopes have vastly different half-lives, ranging from small fractions of a second to billions of years.</p> <ul style="list-style-type: none"> • Learning Objective (7.C.3.1):The student is able to predict the number of radioactive nuclei remaining in a sample after a certain period of time, and also predict the missing species (alpha, beta, gamma) in a radioactive decay.
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Essential Questions	
(What questions will the student be able to answer as a result of the instruction?)	
<ol style="list-style-type: none"> 1. What particles make up the nucleus? What is the general term for them? What are those particles composed of? 2. What is the definition of the atomic number? What is its symbol? 3. What is the definition of the atomic mass number? What is its symbol? 4. What is the definition of mass defect? 5. What is the definition of binding energy? 6. What is the spontaneous emission of radiation from nuclei called? What are the three types? 7. What is nuclear fusion and where does it occur? 	
Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
<p>By the end of this unit, students will know:</p> <ul style="list-style-type: none"> • Mass defect and binding energy • Alpha decay • Beta decay • Gamma Radiation • Fission • Fusion 	<p>By the end of this unit, students will be able to:</p> <ul style="list-style-type: none"> • Solve problems using the following equation: $E = \Delta mc^2$ • Solving problems involving nuclear reactions
Assessment	
(What is acceptable evidence to show desired results (rubrics, exam, etc.)? Attach Copy	
<p>During the Smart Notebook lesson designed to introduce concepts, students will be continually questioned on these concepts using a combination of class work/homework questions and the SMART Response system. Classwork and Homework questions will be discussed as a class and misconceptions will be addressed by the teacher prior to the formal evaluations listed below.</p> <ul style="list-style-type: none"> • Nuclear Physics Test <p>Other assessments on the NJCTL website are optional and can be used as needed.</p>	

(What is the sequence of activities, learning experiences, etc, that will lead to desired results (the plan)?			
Day	Topic	Classwork	Homework**
1	Nuclear Structure, Radius and Atomic Mass	Presentation to slide 29 Problems 1-6	Problems 7-12 & MC 1-10
2	Binding Energy and Mass Defect	Presentation to slide 40 Problems 13-15	Problems 16-18 & MC 11-20
3	Radioactivity and Half Life	Presentation to slide 60 Problems 19-21 & 25-27	Problems 22-24 & 28-30 & MC 21-30
4	Nuclear Reactions, Fission and Fusion	Presentation to end Problems 31-38 & 47-49	Problems 39-46 & 50-52 & MC 31-32
5	Review	Review MC	Study for Test
6	Test	Nuclear Physics Test	N/A

* It may not be possible to complete labs in the order stated due to lab schedules. Other labs on the NJCTL website are option and can be used as needed.

**HW Problems are currently not scaffolded from least to most difficult, but are instead listed in order of topic. Teacher should pay special attention at the end of each class period when assigning HW so that only problems related to the topic that was taught are being assigned.